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AGRICULTURAL SECTION.

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# AGRICULTURAL METEOROLOGY

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# U N I T E D  S T A T E S.

# AGRICULTURAL METEOROLOGY IN THE UNITED STATES.

The daily program of work of the Weather Bureau comprises a very far-reaching service of direct and immediate practical and economic benefit to agriculture. The forecast work is based on observations, taken simultaneously twice daily at about 200 stations in the United States, so placed geographically as to cover all sections of the country, and from points in Canada, the West Indies, Mexico, Central America, Alaska, Hawaiian Islands, Bermuda, Europe, the Far East, and a few other points in the Northern Hemisphere. The reports are received by telegraph, by telephone, and by radio, and are charted at the district forecast centers which are located at Washington, Chicago, New Orleans, Denver, and San Francisco. The forecasts and warnings are deduced therefrom, and are immediately disseminated. The time consumed between the taking of the observations and the issuing of the forecasts and warnings is about one and one-half hours.

Forecasts, covering periods of 36 to 48 hours in advance, are issued twice daily, 8 a.m. and 8 p.m., 75th meridian time. They are telegraphed to a large number of distributing points, and thence further disseminated by telegraph, telephone, radio, and mail, to several thousand cities, towns, and communities. They are furnished also to press associations and to newspapers, and are published in practically every daily newspaper in the United States. Printed maps and bulletins, containing weather reports and forecasts, are mailed or delivered to commercial, marine, agricultural, industrial, and educational institutions in less than three hours after the observations are taken.

A WEEKLY OUTLOOK is issued each Saturday, for the six days beginning with the ensuing Monday, and covers the entire United States, which is divided for the purpose into convenient zones. They are telegraphed to designated centers whence they are further disseminated by telegraph, telephone, and mail, and are published in Sunday and Monday papers. These outlooks were originally intended more particularly for agricultural interests, but their value was soon recognised by manufacturers, railroads, shippers, and other commercial interests, and are extensively used by them.

SHIPPERS' FORECASTS. - Forecasts of minimum temperatures expected within the next 24 to 36 hours are made daily during the winter months, for the guidance of shippers of perishable products, by officials in charge of stations located in commercial centers. They are also issued from time to time, as occasion demands, during the summer months, whenever damaging high temperatures are expected. Shipments of perishable products are regulated by these forecasts to a large degree, and the saving in loss of foodstuffs, and in claims for damage in transit, amount to several million dollars annually in such shipping centers as New York, Chicago, and Philadelphia.

WARNINGS OF FLOODS AND REPORTS OF RIVER STAGES. - The River and Flood Service of the Bureau supplies warnings of oncoming floods and dangerous high water, and also gives advices of river stages for navigation and other purposes at times ordinary conditions prevail. In the far West snow measurements and surveys give useful advices concerning summer water supply for streamflow, irrigation, etc. The flood warnings of the Weather Bureau have resulted in the saving of thousands of lives and millions of dollars worth of property.

COLD WAVE WARNINGS. - Sudden and damaging low temperatures, which frequently occur and sweep across this country during the winter season, have acquired the name of cold waves and blizzards. Forecasts of such are issued from 24 to 36 hours in advance, and are disseminated throughout the threatened regions. These warnings are valuable, especially to railroads in the making up of trains and in the maintenance of schedules, to shippers of foodstuffs, to public utilities, stock raisers, citrus fruit growers, florists, and other innumerable business interests.

FROST WARNINGS FOR PROTECTION OF ORCHARDS AND OTHER CROPS. Whenever conditions indicate the occurrence of damaging frosts, detailed and specific warnings and advices are disseminated by the Bureau to all localities affected, where growers are prepared to protect their crops by the various means in vogue. In many instances industries would be too hazardous to be profitable without the Weather Bureau warnings. This is true especially of early trucking in the South Atlantic and Gulf States, and of citrus fruit production in sections of the Pacific coast. This work has become so important in the latter districts that trained meteorologists are assigned for a few months each year to certain localities during the danger season to give warning of the minimum temperature during the night and advice as to the extent to which protective measures must be taken. The frost warnings also serve for the protection of sugar cane, alfalfa seed crops, home gardens, flower beds, etc. Alfalfa seeds are very susceptible to damage and frosts are frequent about the time the crop is maturing. It is estimated that the crop increases in value at the rate of about $5.00 an acre each 24 hours near the harvesting period; if cut too early, much loss is sustained, but heavier losses may occur from frost, if not cut soon enough. The growers depend on the Weather Bureau to keep them advised, and vigorously push harvesting operations when a warning is received.

In the efficient prosecution of the fruit-frost work, extensive temperature surveys in the principal citrus and deciduous fruit districts of the West, particularly in Arizona, California, Oregon, and Washington, are being made, in co-operation with organizations of fruit growers, as an aid in frost protection. Severe and harmful freezes sometimes occur in the citrus districts, and damage would be much greater if it were not for the special service rendered by the Weather Bureau.

In regions where frost protective methods have been most fully developed, and where growers are best organized to profit by the Weather Bureau service, the work is held in very high esteem, and local organizations not only write to the Bureau many flattering and commendatory letters, but are ready to put up their money, through organizations, to carry the work beyond that possible from the limited funds of the Bureau.

FRUIT SPRAY AND HARVEST WEATHER FORECASTS. - To meet urgent requests from progressive horticulturists, a special service has been conducted, for a number of seasons, in connection with orchard spraying activities in some important apple-growing regions. The work is carried on in co-operation with State Extension and County and Farm Bureau agencies, and consists of special forecasts of rain on which the success of the spraying operations largely depends. Scab, a fungus disease, is the worst enemy of fruit in certain sections. The scab remains dormant as long as the weather is dry, but the spores come into activity when moistened, and, unless killed by spray, the trees may become infected within 24 hours. The problem is to apply the spray just before a rain. When the rains occur, the fungi begin to grow, and are killed by the poison in the spray; if this is applied, and the rains do not occur within three

days thereafter, the effect of the poison is minimized or lost entirely. There are about 12,000 commercial apple growers in seven counties in New York alone who are equipped for spraying. At least three applications are necessary each season. It is estimated that the total cost of apple tree spraying for one season, in the seven counties, is about $3,500,000.00. Therefore, accurate and timely forecasts of coming rains in the spraying season are of great importance to the orchardists in determining where and when the spray shall be applied. In some of the larger orchards three days are required for one application and, consequently, the forecasts must be for a longer period than is covered by the regular forecasts. The work is of a difficult character, and requires the attention and special study of experts. The responsibility placed on the Weather Bureau in giving correct information is apparent; if the forecaster fails to predict rain, and the spray is not applied, the trees become immediately infected; if rain is forecast, and the spray is applied, but the rain fails to materialise, the effect of the spray is lost entirely, or considerably reduced, and heavy losses are sustained by the growers.

A service for the special benefit of farmers, in the harvesting of hay, wheat, and other crops, is conducted in some sections. Forecasts are issued for guidance in the harvesting of such crops as are liable to damage if unfavourable weather occurs between the time of cutting and shocking. The predictions are not for a fixed period, as is the case with the general daily forecasts, but for just as long a period as the forecaster feels that the conditions shown on the current weather map justify a reasonable expectation of accuracy. Sometimes this period is only for 24 hours, and at others three or four days. The prognostications are worded to apply to the particular purpose, and to convey to the farmer the degree of confidence that the forecaster has in his forecasts. Illustrations of these forecasts are: "Conditions excellent for drying weather Wednesday and Thursday; Friday uncertain", or "Outlook for harvesting next two days uncertain; rain very likely". This work also is conducted in co-operation with County and Farm Bureau agents who disseminate the forecasts by telephone to the individual farmers.

THE USE OF PROTECTIVE DEVICES AGAINST ADVERSE WEATHER. - Agricultural and horticultural interests make practical use of the Weather Bureau forecasts and warnings in protecting their crops from frost. The early trucking industry, so extensively carried on in the regions bordering on the Gulf and south Atlantic coasts, and in Florida, and which has increased so greatly in recent years, is largely dependent for its success on the co-operation of the Weather Bureau in this particular, and the growers of oranges and other fruits in Florida and California have received great benefit, or escaped losses aggregating many millions of dollars. The value of the orange bloom, vegetables, and strawberries protected and saved on a single night, in a limited district in Florida, through the instrumentality of warnings of freezing weather sent out by the Bureau, was reported as over $100,000.00. In the citrus fruit districts of California it is reported that fruit to the value of $14,000,000.00 was saved by taking advantage of warnings issued by the Bureau during one cold wave.

The deciduous fruit districts of Washington, Oregon, Idaho, Utah, Colorado, and other sections rely upon the warnings of the Bureau to guide them in smudging and heating their orchards on the occurrence of frosts or freezing weather during the blossoming period. The railway and transportation companies make continued use of the forecasts in all of their shipments. Perishable products are protected against temperature extremes by icing, or heating, as conditions may require. Oftentimes shipments of perishable goods are accelerated when it is found possible to carry them to their destination in advance of the expected unfavourable temperature

conditions. When this can not be accomplished, goods en route are run into roundhouses for protection. An advance notice of a cold wave will also often hold up a contemplated shipment until after the freeze has passed, and if the cold is protracted the companies will refuse to receive consignments of goods likely to be injured by low temperatures. These precautions apply, in some instances, to prospective temperatures within comparatively narrow limits. Bananas, for example, require very careful handling, and must be kept at a temperature of 58° to 65° F. during shipment, as a temperature below 55° chills the fruit sufficiently to cause a deterioration in quality, while a temperature above 65° inside the car will produce over-ripening. As bananas generate heat rapidly after being placed in the car, the problem of maintaining the requisite temperature becomes a delicate one, involving careful ventilation and a study of actual and expected temperature conditions along the entire line of transit.

Similar precautions, based on the information of the daily forecasts, and supplemented by a study of the daily weather map, apply to shipments of vegetables, fruit, eggs, and other products liable to damage from extremes of temperature. On the other hand, most meats are best shipped in cold weather, although the use of refrigerator cars prevents loss, and the shipment of hogs and live cattle by freight is avoided, if possible, when a hot wave is expected. High temperatures are also hurtful to other shipments, especially of fish and oysters, so that the question of the proper amount of ice to be used is intimately connected with the forecasts issued by the Bureau. The daily forecasts and the reports of general weather conditions likewise assist in determining the points to which many shipments of perishable articles are directed, in order to meet the irregular demands that are frequently dependent upon the kind of weather that prevails in a given section. The movement of eggs kept in storage, for instance, is largely regulated by temperature changes, the announcement of a cold wave being usually followed by brisker shipments from western supply districts to the eastern markets, in anticipation of a rise in price.

In the agricultural districts the frost and cold wave warnings are invaluable to the trucker and fruit grower, especially in spring, when the tender vegetables are protected by covering with paper, cloth, or soil, and fruit is safeguarded by orchard heating, irrigation, or other methods designed to maintain the temperature above the danger point. In the fall, these warnings are utilized in the cranberry regions for flooding the bogs until after the cold weather has passed, or danger of frost is over. Many crops, such as beans and grapes, are saved by being picked in advance of a freeze, while tobacco and unmature corn are cut at once upon advance notice of damaging cold weather. Potato digging is suspended and the dug potatoes removed from the field, and sugar cane is cut and windrowed upon receipt of such advices, immense savings having resulted in the sugar districts of Louisiana because of such action.

Fruit growers are often given valuable service through the supplying of advance warnings of impending cold waves, which enables them to make adequate preparation for fighting frost. For example, acting on the advice of fruit-frost specialists, that an unusually severe frost would likely be experienced in a day or so, which would probably require an additional fuel supply, the growers in southern California on Christmas Eve and Christmas Day, 1924, to meet the impending emergency, rushed into the orange groves 300 carloads and 175 truckloads of oil, in addition to the full capacity of their regular freight supply. It later proved that if the additional fuel had not been provided vast quantities of fruit would have been lost. In the Pacific States alone there are some 4,000,000 orchard heaters in use, in the operation of which the

growers largely depend on advices and warnings given by the Weather Bureau.

In the raisin-growing districts of California rain forecasts are of great value. The raisin crop, while drying, is extremely susceptible to injury from rain, and the warnings enable the producers to protect the fruit by stacking and covering the trays. The accuracy of the rain forecasts for this region, and the system for their distribution, have been so complete that practically no loss from this cause has occurred for years.

WEATHER AND CROP SERVICES. - The United States is preeminently an agricultural country, and the farming industry is basic to our national prosperity to a greater extent than in any other of the leading countries of the world. The farmer's working partner, so to speak, is the weather, and it is essential that he and all others interested in the important problem of supplying the Nation with food be kept in close contact with prevailing weather conditions and their effect on growing crops and farming operations. To supply this need special weather and crop services are maintained by the Weather Bureau, through which such information is made available to all interested persons. Two more or less distinct services are maintained -- one a daily and the other a weekly.

Daily cotton, corn and wheat, and sugar and rice region services are maintained. In these a large number of special meteorological observers, well distributed throughout the principal agricultural sections of the country, make weather observations and their reports are collected by telegraph and published daily in bulletin form at designated central Weather Bureau stations in different sections of the country. These bulletins show for the various stations, and for each 24-hour period, the highest and lowest temperatures, the general character of the weather, and the amount of rainfall.

In the weekly service the officials in charge at designated central Weather Bureau stations for the several States collect information weekly from special and co-operative meteorological observers and a large number of correspondents relative to prevailing weather conditions and their effect on farming operations and crop growth. These officials make weekly reports to the Central Office at Washington, D.C., where the information is tabulated and summarized into a weather and crop report for the entire country. This is released each Wednesday at 10 a.m., and published in "The Weekly Weather and Crop Bulletin", which includes meteorological tables and charts, showing graphically the precipitation and temperature conditions throughout the country. In addition, there is published a local weather and crop summary at each State center, relative to conditions prevailing in the respective States. There is also published at New Orleans a weekly cotton region bulletin covering conditions in the Cotton Belt, and at Chicago a similar report covering the principal grain-producing States.

Many circulated stories and rumours that affect the price of grain and other agricultural products, and the agricultural industry in general relate to the weather. By maintaining these services dependable information is supplied at frequent intervals, whereby the public is kept acquainted with the actual conditions prevailing.

WEEKLY RANGE AND CATTLE SERVICE. - Because of the large expanse of the western grazing country, some sections of the area may have severe drought and others ample moisture to supply sufficient feed for livestock, and some to spare. It then may become necessary to ship stock from unfavorable to more favorable regions. Again, bankers and others who lend money on livestock require information as to weather conditions and their effect on the range and stock throughout the grazing area. To meet these needs a cattle region service is maintained, through which reports are received each week from special observers in different sections of the grazing area as to prevailing weather conditions and their effect on the range and livestock. These reports are published as weekly bulletins at designated central stations in the range country.

EXPERIMENTAL STATIONS. - Unfortunately there has been no methodical and systematic collection at experiment stations, side by side, of crop data, on the one hand, and weather data, on the other, for the purpose of correlations. With the general data available as to crop yields, by State, or smaller geographic units, and the corresponding weather data, considerable investigational work, by means of mathematical correlations and otherwise, has been and is being done by officials of the Bureau, as time permits, and a number of papers have been published on the subject. These include studies of weather effect directly on yield, and also on related problems, such as the blooming time of fruit, the weather relation to planting and harvesting dates, influence on insect pests, the broader relation of climate to the geographic distribution of crops, and to types of farming, the relation of rainfall to the grazing capacity of ranges, etc. Also, rather extensive investigational work has been done in important fruit areas in the making of temperature surveys to determine the susceptibility to frost of lands with different topographic features, as a guide in planting new orchards, and in protecting old ones from damage by frost.

CROP FORECASTING. - The crop reporting agencies of the Department of Agriculture, in their forecasting work, frequently confer with Weather Bureau officials, in regard to the prevailing weather, and the influence on crop growth, as shown by weather and crop studies, and they take into consideration these demonstrated influences in making forecasts of probable yields. These are considered as additions to other information at hand and are given due weight in the final determinations, but, as yet, official forecasts of yield are not attempted from weather data alone.

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